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Abstract

COEXTRACTION OF THORIUM AND CERIUM BY NEUTRAL PHOSPHORUS ORGANIC COMPOUNDS

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The study of coextraction of thorium and cerium is very important due to the occurrence of the second in concentrates of the first obtained in the processing of monazite.

The values of the separation coefficient of the two elements could be calculated on the basis of partition data. However, the partition coefficient values are affected by the metal concentration in the aqueous phase; consequently the values of the separation coefficient are changed. Moreover it was found that cerium partition coefficient sharply decreases with increase of thorium concentration in the aqueous phase. This is due to competition between cerium and thorium for the free solvent; thorium forms more stable complexes with the solvent molecules. The separation coefficient of the two elements (ξ) can be calculated on the basis of the confirmed extraction mechanism. ξ is expressed by the following relation:

$$\xi = D_{Th} / D_{Ce} \qquad (1)$$

On the basis of the extraction mechanism of the two elements, it is easy to show that ξ can be expressed by the following equation:

$$\xi = \frac{K_{Th}}{K_{Ce}} \cdot \frac{[NO_3^-] \left(1 + \Sigma \beta'_j [NO_3^-]\right)}{S \cdot \left(1 + \Sigma \beta_j [NO_3^-]\right)} \qquad (2)$$

Where K_{Th} and K_{Ce} are the equilibrium constants of the extraction reaction of the two elements, β_j and β'_j are the stability constants of thorium and cerium complexes with the NO_3^- ions.

β_j and β'_j and also K_{Th} and K_{Ce} for TBP and DAMPK (which is a member of alkyl phosphonates) were determined experimentally.

The value of ξ thus depends on the total nitrate ion concentration in the aqueous phase and on the free solvent concentration in the organic phase. It is to be noted that the above equation holds only for the extraction at low acidities. Equation (2) may be written in the following form:

$$\xi = \frac{K_{Th}}{K_{Ce}} \cdot \frac{1}{S} \cdot f\left([NO_3^-]\right) \qquad (3)$$

The values of $f([NO_3^-])$ and the corresponding ξ values were calculated at different nitrate ion concentrations in the aqueous phase for 1 M solvent concentration. It was found that the calculated and experimental ξ values agree with each other which is an indication of the correctness of the given mechanism. It was found also that the separation coefficient of thorium and cerium has a maximum value at an equilibrium nitrate concentration of 1.6 M. The maximum value of 1 M TBP is equal to ~48.

In technology thorium is usually extracted from solutions with high metal concentrations, and therefore the solvent will be almost completely saturated with thorium. This brings about an increase in the value of ξ as indicated by equation (3).